220 and 230 Programmable Sources

The demand on researchers, designers, and evaluation engineers for better device characterization has generated a widespread need for programmable, low-level DC sources. And, as an experienced manufacturer of automatic wafer measuring equipment, Keithley knows the importance to the user of instrument compatibility and ease of system integration. The 220 programmable current source and 230 programmable voltage source find major applications in semiconductor characterization, materials research, and ATE systems.

Both models incorporate a 100-step, programmable memory buffer, useful in applications where either a fixed number of outputs is repeated or a complex waveform of discrete steps must be generated.

In system applications, the buffer can be loaded through the bus, and the 220 or 230 can be commanded to sequence through memory while the controller is busy on other tasks.

The TRIGGER IN/OUT feature, when used in the STEP mode, allows the source to synchronize the measurements of other instruments. The TRIGGER OUT occurs after the completion of dwell time; TRIGGER IN causes the 220 or 230 to advance to its next program step. This provides the capability to perform a preset source measurement without a computer.

220 Rear Panel

230 Rear Panel

Four TTL-compatible input and output (I/O) lines are provided on each model to receive and generate system commands. In a typical application, a source can be programmed to generate an SRQ (service request) to the controller if a system element such as a foot pedal switch, mechanical stop, or over-temperature condition is detected.

The I/O can provide a means for the customer to shut down the power supply for safety in a system environment. Digital I/O is an example of the convenience features that make the Models 220 and 230 easy to use in your test system.

The **230-1** is a special version of the 230 with the necessary connectors for compatibility with the Model 82 Simultaneous C-V Systems.

MODEL 220 CURRENT SOURCE

- ±0.5pA to ±101mA DC output
- $10^{14}\Omega$ output resistance
- ±1V to ±105V programmable V-LIMIT

MODEL 230 VOLTAGE SOURCE

- ±50µV to ±101V DC output
- ±2mA, ±20mA, ±100mA programmable I-LIMIT
- Remote sensing

ORDERING INFORMATION

220	Programmable Current Source with instruction manual, programming guide, Model 6011 Input Leads, 1.5m (5 ft), Triax to Clips
230	Programmable Voltage Source with instruction manual and programming guide
230-1	Programmable Voltage Source with instruction manual and programming guide (for Model 82, 82-WIN Simultaneous CV Systems)

This product is available with an **Extended Warranty.** See page 635 for complete ordering information.

QUESTIONS?
1-800-552-1115 (U.S. only)
Call toll free for technical assistance, product support or ordering information, or visit our website at **www.keithley.com**.

220 and 230 Programmable Sources

IEEE-488 BUS IMPLEMENTATION (220, 230)

MULTILINE COMMANDS: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.

UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.

INTERFACE FUNCTIONS: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

INTERNAL PROGRAMMABLE PARAMETERS: Display Mode, Output, Prefix Data Format, EOI, SRQ (including mask for over Limit), Program Mode, Range, Trigger Mode, Terminator Character, Inputs (Source, Limit, Dwell Time, 100-Point Memory Locations), Output Status, Digital Self Test.

DIGITAL I/O PORT: A separate I/O port consisting of four input and four output lines as well as common (IEEE-488) and +5V DC. Outputs will drive one TTL load. Inputs represent one TTL load. The 220 or 230 can be programmed to generate an "SRQ" upon any change in the four bit input data. Mating connector supplied.

MODEL 220 CURRENT SOURCE

RANGE	MAXIMUM OUTPUT	ACCURACY (1 Year) 18°–28°C	STEP SIZE	TEMPERATURE COEFFICIENT/°C 0°–18°C & 28°–50°C	NOISE (pk-pk of range)	3dB BANDWIDTH
100 mA	±101.00 mA	0.1 % + 50 µA	50 µA	0.01 % + 2 µA	100 ppm	0.1 Hz to 30 kHz
10 mA	±19.995 mA	0.05% + 10 µA	5 µA	0.005% + 200 nA	100 ppm	0.1 Hz to 100 Hz
1 mA	±1.9995 mA	0.05% + 1 µA	500 nA	0.005% + 20 nA	100 ppm	0.1 Hz to 100 Hz
100 µA	±199.95 µA	0.05% + 100 nA	50 nA	0.005% + 2 nA	100 ppm	0.1 Hz to 100 Hz
10 µA	±19.995 µA	0.05% + 1 nA	5 nA	0.005% + 200 pA	100 ppm	0.1 Hz to 100 Hz
1 µA	±1.9995 µA	0.1 % + 1 nA	500 pA	0.01 % + 20 pA	100 ppm	0.1 Hz to 100 Hz
100 nA	±199.95 nA	0.3 % + 100 pA	50 pA	0.02 % + 2 pA	100 ppm	0.1 Hz to 100 Hz
10 nA	±19.995 nA	0.3 % + 10 pA	5 pA	0.02 % + 200 fA	200 ppm	0.1 Hz to 10 Hz
1 nA	±1.9995 nA	0.4 % + 2 pA	500 fA	0.02 % + 200 fA	400 ppm	0.1 Hz to 10 Hz

OUTPUT RESISTANCE: $>10^{14}\Omega$ (on 1nA range).
OUTPUT CAPACITANCE: <20pF.
LINE REGULATION: <0.01% for AC power line changes within specified limits.
VOLTAGE LIMIT: Bipolar, 1V to 105V in 1V programmable steps.
RESPONSE TIME: <3ms to within 0.1% of programmed change.
TRANSIENT RECOVERY TIME: <3ms to rated accuracy following any change in compliance voltage.
GUARD OUTPUT:
Maximum Load Capacitance: 10nF.
Maximum Load Current: Absolute total (Output + Guard) not to exceed 105mA.
Accuracy: ±1mV (excluding output lead voltage drop).

PROGRAM MEMORY:
Number of Locations: 100.
Range of Dwell Times: 3ms to 999.9s.
Accuracy of Dwell Time: ±(0.05%+200µs).
OUTPUT LOAD: Output load must be non-inductive.
EXTERNAL TRIGGER: TTL-compatible EXTERNAL TRIGGER INPUT and OUTPUT.
OUTPUT CONNECTIONS: Teflon® insulated 2-lug triax connector (Specialty Connector #30JR121-1) for output; five-way binding posts for GUARD, OUTPUT COMMON, and CHASSIS; BNC (chassis isolated) connectors for EXTERNAL TRIGGER INPUT and OUTPUT, Amphenol or Cinch Series 87 IEEE and printed circuit digital I/O port. All connections on rear panel.

MODEL 230 VOLTAGE SOURCE

RANGE	MAXIMUM OUTPUT	ACCURACY (1 Year) 18°–28°C	STEP SIZE	TEMPERATURE COEFFICIENT/°C 0°–18°C & 28°–50°C
100 V	±101.00 V	0.05 % + 50 mV	50 mV	0.005% + 0.5 mV
10 V	±19.995 V	0.05 % + 10 mV	5 mV	0.005% + 100 µV
1 V	±1.9995 V	0.05 % + 1 mV	500 µV	0.005% + 25 µV
100 mV	±199.9 mV	0.075% + 300 µV	50 µV	0.01 % + 25 µV

MAXIMUM CURRENT LIMIT: ±100mA (–0, +20%).
SELECTABLE CURRENT LIMIT: ±100mA, ±20mA, ±2mA (–0, +20%).
LINE REGULATION: <0.01% for AC power line changes within specified limits.
NOISE: (150µV + 50ppm range) p-p, 0.1Hz to 300Hz; 5mV p-p, 0.1Hz to 300kHz. Specification applies for local sensing only, typical.
RESPONSE TIME: <3ms to within 0.1% of programmed change for Current Limit of at least 20mA.
TRANSIENT RECOVERY TIME: <3ms to rated accuracy for Current Limit of at least 20mA.
OUTPUT IMPEDANCE:

SELECTED CURRENT LIMIT	OUTPUT IMPEDANCE
2 mA	1 mΩ + 10 mH
20 mA	1 mΩ + 2 mH
100 mA	1 mΩ + 1 mH

SENSING: Rear panel selectable REMOTE and LOCAL sensing.
REMOTE SENSING:
Maximum Lead Drop (per lead): 0.5V.
Maximum Sense Lead Resistance (per lead): 5Ω.
PROGRAM MEMORY:
Number of Locations: 100.
Range of Dwell Times: 3ms to 999.9s
Accuracy of Dwell Time: ±(0.05% + 200µs).
EXTERNAL TRIGGER: TTL-compatible EXTERNAL TRIGGER INPUT and OUTPUT.
OUTPUT CONNECTIONS: Five-way binding posts for OUTPUT, OUTPUT SENSE, COMMON, COMMON SENSE, and CHASSIS GROUND; BNC (chassis isolated) connectors for EXTERNAL TRIGGER INPUT and OUTPUT. All connections on rear panel.

GENERAL (220, 230)

DISPLAY: 0.5 in LED digits, 4½-digit signed mantissa, 1-digit signed exponent.
SYSTEMS COMPATIBILITY: IEEE-488-1978.
LIMIT INDICATIONS:
Model 220 (Voltage Limit): "V-LIMIT" LED will blink.
Model 230 (Current Limit): "I-LIMIT" LED will blink.
MAXIMUM ALLOWABLE COMMON MODE VOLTAGE (OUTPUT or OUTPUT COMMON to CHASSIS): 250V rms, DC to 60Hz.
SELF TEST: Digital RAM, ROM, front panel LEDs upon power ON.
EMC: Conforms to European Union Directive 89/336/EEC.
SAFETY: Conforms to European Union Directive 73/23/EEC (meets EN61010-1/IEC 1010).
WARM-UP: 1 hour to rated accuracy.
POWER: 105–125 or 210–250V AC (internal switch selected), 50 or 60Hz, 60W maximum (80VA maximum). 90–105 or 180–210V AC operation available.
COOLING: Internal fan for forced air cooling.
ENVIRONMENTAL LIMITS: Operating: 0°–50°C; up to 35°C at 70% non-condensing relative humidity. **Storage:** –25° to 70°C.
DIMENSIONS, WEIGHT: 127mm high × 216mm wide × 359mm deep (5 in × 8½ in × 14⅛ in). Net weight 4.4kg (9 lb 11 oz).
ACCESSORIES SUPPLIED (220): Model 6011 Triaxial Test Lead (3 ft). **(220, 230):** Instruction manual, programming guide.

ACCESSORIES AVAILABLE

TEST LEADS (220)

6011	Input Leads, 2-Slot Male Triax to Alligator Clips, 1.5m (5 ft)
6011-10	Input Leads, 2-Slot Male Triax to Alligator Clips, 3m (10 ft)

CABLES (220 & 230)

7007-1	Shielded IEEE-488 Cable, 1m (3.3 ft)
7007-2	Shielded IEEE-488 Cable, 2m (6.6 ft)
7008-3	IEEE-488 Digital Cable, 0.9m (3 ft)
7008-6	IEEE-488 Digital Cable, 1.8m (6 ft)
7024-3	Low Noise Triax Cable, 0.9m (3 ft) (220 only)
7024-10	Low Noise Triax Cable, 3m (10 ft) (220 only)

ADAPTERS (220)

6146	Triax Tee Adapter
6147	2-Slot Male Triax to Female BNC Adapter
6167	Guarded Input Adapter
6172	2-Slot Male to 3-Lug Female Triax Adapter

RACK MOUNT KITS (220 & 230)

10191	Single Fixed Rack Kit
10192	Dual Fixed Rack Kit
4288-4	Rack Mount Kit

See page 235 for descriptions of all accessories.

QUESTIONS?
1-800-552-1115 (U.S. only)
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